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(54) **STEERING FUSE**

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B63H 25/10	(2006.01)
F16D 9/06	(2006.01)

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CPC ***B63H 25/52*** (2013.01); ***F16D 9/06*** (2013.01); ***B63H 25/10*** (2013.01)

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CPC B63H 23/00; B63H 23/06; B63H 25/10; B63H 25/52; B65G 43/02; F16D 43/20
USPC .... 114/144 R; 440/75, 84, 86
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,146,755 A		9/1964	Morse	
3,238,914 A		3/1966	Swallow	
4,521,201 A		6/1985	Watanabe	
4,701,141 A		10/1987	Sumigawa	
4,840,136 A		6/1989	Brandt	
4,842,559 A		6/1989	Litjens et al.	
5,649,844 A	*	7/1997	Caricof et al.	440/75

FOREIGN PATENT DOCUMENTS

GB	857394	12/1960

* cited by examiner

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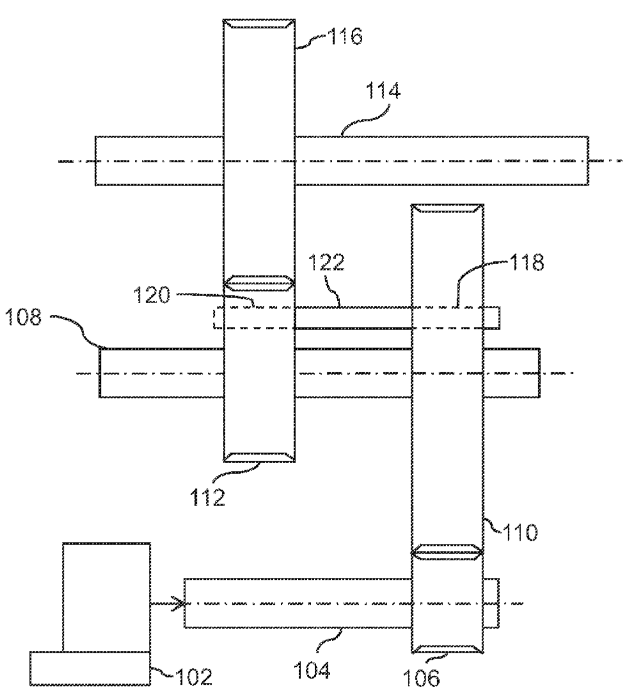
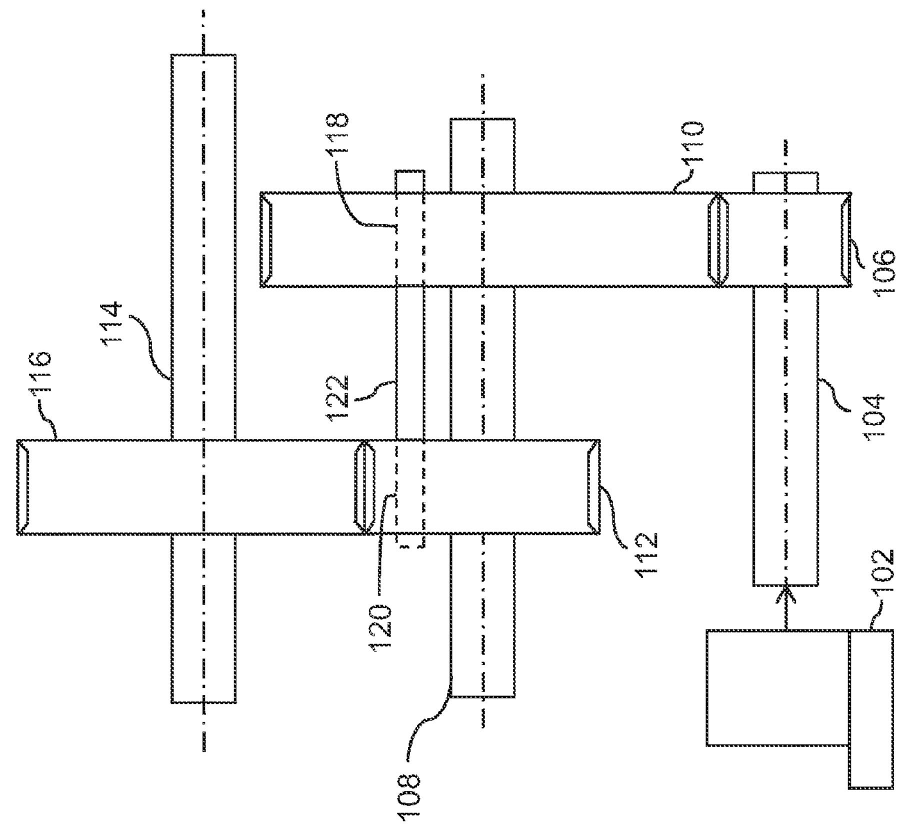
(57) **ABSTRACT**

A steering system for a marine pod drive is disclosed. The system includes a driving pinion attached to a driving shaft. The system further includes a driven gear mounted to a driven shaft. Moreover, the system includes an intermediate gear mounted to an intermediate shaft and in mesh with the driving pinion. Furthermore, an intermediate pinion is attached to the intermediate shaft. The intermediate pinion is in mesh with the driven gear on the driven shaft. Moreover, the intermediate pinion may be fastened with the intermediate gear by a shear pin such that the intermediate pinion rotates with the intermediate gear. The shear pin may be configured to shear when a torque transmitted through the system exceeds a rated torque value, thereby causing the intermediate gear to rotate freely on the intermediate shaft.

1 Claim, 1 Drawing Sheet

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STEERING FUSE

TECHNICAL FIELD

The present disclosure generally relates to marine vessels. More, specifically, the present disclosure relates to torque transmission in a steering system for a marine pod drive.

BACKGROUND

Typically, vehicles and/or machines include a fuel-powered engine that may provide mechanical power to various transmission mechanisms. A transmission mechanism, such as a steering system, generally includes a driving member and a driven member. The driving member transfers the mechanical power from the fuel-powered engine to one or more loads, such as a steering load. An exemplary driving member may be a driving gear mounted to a driving shaft, and an exemplary driven member may be a driven gear in mesh with the driving gear and mounted to a driven shaft. The driving member may be continuously engaged with the driven member or selectively engaged with the driven member. The driving shaft may be rotated by the fuel-powered engine or an electric motor. Hence, rotation of the driving shaft may be transmitted to the driven shaft through the driving member and the driven member. In other words, the driving member transmits certain moment of force or torque to the driven member attached on the driven shaft. The driven shaft may be further connected to a load. For example, the driven shaft may be connected to a steering link of a vehicle. Hence, the driving shaft may transmit a torque to the driven shaft via the driving and the driven members.

Usually, the driving member and the driven member are designed to transmit the torque in a pre-specified range. In case the transmission mechanism experiences an excessive load, the driven member and/or the driving member may fail. In other words, gears of the driving member and the driven member may fracture when the load exceeds the tensile strength of the gear material. Load may also increase due to bearing seizure, any foreign material passing through the mesh of the gears, sudden failure of the engine, or misalignment of the gears. Also, if the torque transferred by the driven member and the driving member exceeds the pre-specified range, the complete transmission mechanism may fail.

One of the existing systems provides a keyway and key mechanism to prevent damage to gears in an event of excessive load. In such mechanisms a key is used to attach a rotating gear to a gear shaft. The key can be inserted in a key seat or keyway in the gear shaft. The keyway can be a grove or a pocket provided on the gear shaft such that the key can be fitted inside the keyway and the key can temporarily fasten the gear with the gear shaft. Hence, the keyway and key mechanism prevents any relative motion between the gear and gear shaft. Thus, in the condition of excessive load, the keyway or the key may shear. However in such a system, the gear and the gear shaft may need to be dis-assembled or replaced in an event of failure of the key or the keyway.

SUMMARY

The disclosure relates to a steering system for a marine pod drive. The system includes a driving shaft, and a driving pinion attached to the driving shaft. The system further includes a driven shaft, and a driven gear mounted to the driven shaft. Furthermore, the system includes an intermediate shaft. Additionally, the system includes an intermediate gear mounted to the intermediate shaft and in mesh with the driving gear. Also the system includes an intermediate pinion attached to the intermediate shaft and in mesh with the driven gear. Furthermore the system includes, a fuse pin configured to fasten the intermediate gear with the intermediate pinion. Moreover, the fuse pin is configured to shear when a transmitting torque in the system exceeds a rated torque value.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** illustrates an exemplary steering system according to an embodiment of the present disclosure.

DETAILED DESCRIPTION

FIG. **1** illustrates an exemplary steering system **100** for a marine pod drive. The steering system **100** may be configured to transmit rotational motion from one shaft to another shaft. The steering system **100** is shown to include a drive motor **102**, a driving shaft **104**, a driving pinion **106**, an intermediate shaft **108**, an intermediate gear **110**, an intermediate pinion **112**, a driven shaft **114**, and a driven gear **116**.

The steering system **100** may be configured to transfer rotational motion from the drive motor **102** to the driven shaft **114**, via the driving shaft **104**, the driving pinion **106**, the intermediate shaft **108**, the intermediate gear **110**, the intermediate pinion **112**, and the driven gear **116**. The drive motor **102** may be a power source for providing rotary motion to the driving shaft **104**. For example, the drive motor **102** may be an engine, an electric motor, a hydraulic motor, a pneumatic motor, a crank shaft mechanism, and the like. The drive motor **102** can be configured to rotate the driving shaft **104**. Further, the driving pinion **106** may be attached to the driving shaft **104** such that the driving pinion **106** rotates with the rotation of the driving shaft **104**. In one embodiment, the driving pinion **106** can be mounted to the driving shaft **104** by a mounting mechanism known in the art. For example, the driving pinion **106** may be welded, have splines, internal gears, a key and keyway mechanism, a square hole, or at one least flat surface hole in the driving pinion **106** that mates with a similar design on the driving shaft **104**. Thus, the rotation of the driving shaft **104** rotates the driving pinion **106**. In an embodiment, the driving pinion **106** may be integral to the driving shaft **104**. In an embodiment, as illustrated in FIG. **1**, the driving pinion **106** may be casted or machined as a single unit with the driving shaft **104**, thus can be an integral part of the driving shaft **104**.

The rotary motion of the driving shaft **104** may be transmitted to the intermediate shaft **108**. The intermediate shaft **108** can include the intermediate gear **110**. The intermediate gear **110** can be mounted to the intermediate shaft **108** and in mesh with the driving pinion **106**. In an embodiment, the intermediate shaft **108** can be positioned adjacent to the driving shaft **104** in a manner such that the intermediate gear **110** is in continuous mesh with the driving pinion **106**. In other words, the rotary motion of the driving shaft **104** can be transmitted to the intermediate shaft **108** via the driving pinion **106** and the intermediate gear **110**. The intermediate gear **110** can be mounted to the intermediate shaft **108** by a mounting mechanism known in the art. It may be noted that the intermediate gear **110** can be removeably mounted to the intermediate shaft **108** in a manner such that the intermediate gear **110** can either rotate freely on intermediate shaft or be fastened to rotate with the intermediate shaft **108**. In other words, the intermediate gear **110** is removeably mounted to the intermediate shaft **108** such that the intermediate gear **110** can rotate freely or slip on the intermediate shaft **108**. The intermediate gear **110** can rotate with the rotation of the driving shaft **104** via the driving pinion **106**, whereas the intermediate shaft **108** can remain stationary. It can be contemplated that the intermediate gear **110** can rotate freely on the intermediate shaft **108**, hence does not transfer any rotary motion unless fastened to rotate with the intermediate shaft **108**.

Further, the intermediate shaft **108** includes the intermediate pinion **112**. The intermediate pinion **112** can be attached to the intermediate shaft **108** such that intermediate pinion **112** can be co-axial with the intermediate gear **110**. In an embodiment, the intermediate pinion **112** can be integral to the intermediate shaft **108**. In other words, the intermediate pinion **112** may be casted or machined as a single unit with the intermediate shaft **108**, thus can be an integral part of the intermediate shaft **108**.

It may be noted that the intermediate pinion **112** can be casted as an integral part with on the intermediate shaft **108**, and the intermediate gear **110** can be removeably mounted at a fixed axial distance from the intermediate pinion **112**. The intermediate gear **110** can be mounted to either side of the intermediate pinion **112**.

The steering system **100** also includes the driven shaft **114**. In an embodiment, the driven shaft **114** can be disposed adjacent to the driving shaft **104** and the intermediate shaft **108**. The driven shaft **114** includes the driven gear **116**. The driven gear **116** may be in mesh with the intermediate pinion **112** and mounted to the driven shaft **114** by a mounting mechanism known in the art. For example, the driven gear **116** can be fastened on the driven shaft **114** by a nut and bolt mechanism, welded, have splines, internal gears, a key and key way mechanism, a square hole, or at one least flat surface centre hole in the driven gear **116**, that mates with a similar design on the driven shaft **114**. Hence, the driven gear **116** and the driven shaft **114** can rotate as complete unit. The driven gear **116** can be in mesh with the intermediate pinion **112**. In an embodiment, the driven gear **116** can be a helical gear or a spur gear in mesh with the intermediate pinion **112**.

In an embodiment, the driven shaft **114** can be a steering shaft for a steering mechanism of a marine pod drive. In other words, the drive motor **102** can be steering motor configured to rotate a steering shaft of a marine pod drive through the steering system **100**.

FIG. **1** further illustrates a first hole **118** in the intermediate gear **110** and a second hole **120** in the intermediate pinion **112**. In an embodiment, the first hole **118** and the second hole **120** can be drilled parallel to axis of intermediate shaft **108**. A fuse pin **122** may be disposed inside the first hole **118** and the second hole **120** to fasten the intermediate gear **110** with the intermediate pinion **112**. In other words, the intermediate gear **110** is fastened to rotate with the rotation of the intermediate shaft **108**. The fuse pin **122** can be positioned in the first hole **118** and the second hole **120** in manner such that the intermediate pinion **112**, the intermediate gear **110** and the intermediate shaft **108** rotate as an integral unit. In other words, the fuse pin **122** can be disposed in a manner to cause the rotation of the intermediate pinion **112** and the intermediate shaft **108** with the rotation of the intermediate gear **110**. Thus, the intermediate gear **110** may be fastened and rotated with the intermediate pinion **112**. Examples of the fuse pin **122** may include, but are not limited to, a metal pin, a wedge, a key, and the like. In an embodiment, the fuse pin **122** can be alloy steel or any other suitable material.

In operation, the drive motor **102** rotates the driving shaft **104**. The rotation of the driving shaft **104** causes the rotation of the driving pinion **106**. The driving pinion **106** is in mesh with the intermediate gear **110**. The rotation of the intermediate gear **110** causes the rotation of the intermediate shaft **108**, when the intermediate gear **110** is fastened with the intermediate pinion **112**. In other words, the fuse pin **122** fastens the intermediate gear **110** with the intermediate pinion **112**. Hence the rotation of the intermediate gear **110** causes the rotation of the intermediate pinion **112** and the intermediate shaft **108**. The intermediate pinion **112**, in turn is in mesh with the driven gear **116**. The rotation of the driven gear **116** causes the rotation of the driven shaft **114**. Hence, the steering system **100** may be designed for transmitting torque or rotary motion from the driving shaft **104** to the driven shaft **114** of the steering system **100** for the marine pod drive.

The driving shaft **104** may be rotated by the drive motor **102**. The rotation of the driving shaft **104** may be transmitted to the driven shaft **114** through the driving pinion **106**, the intermediate gear **110**, the intermediate pinion **112** and the driven gear **116**. In other words, the driving shaft **104** is said to have transmitting torque or certain moment of force to the driven shaft **114**. The driving shaft **104** and the driven shaft **114** of the steering system **100** may be designed to transmit rotary motion or torque in a pre-specified range. In other words, the steering system **100** may have a rated torque. For example, the driving shaft **104** may be an output shaft from a power transmission and the driven shaft **114** can be an input shaft of a steering mechanism. The driving shaft **104** and the driven shaft **114** along with the intermediate shaft **108** may be configured to have a value of torque corresponding to a pre-specified range of torque that can be transmitted through them. In other words, torque that can be transmitted from the driving shaft **104** and the driven shaft **114** can be limited by the material, shape or design of the driving shaft **104**, the driven shaft **114**, and intermediate shaft **108**. The amount of torque transmitted can also be limited by the material, design, size, and tooth profile of the driving pinion **106**, intermediate gear **110**, intermediate pinion **112** and the driven gear **116**. Thus, the maximum value of torque that the steering system **100** is capable of transferring can be referred as the rated torque value.

In an embodiment, the driving shaft **104** and the driven shaft **114** may be transmitting torque which may exceed the rated torque value. For example, driving pinion **106** or the driven gear **116** may fracture when the load exceeds the tensile strength of the gear material. Load may also increase due to bearing seizure, any foreign material passing through the mesh of the gears, sudden failure of the engine, or misalignment of the gears. Another cause of failure could be a static or impact load, to the steerable housing that extends below the hull of the marine vessel, which would cause a rotational force on the steering system **100** would exceed the materials of the steering system **100**. In other words, the steering system **100** may be subjected to an excessive torque beyond the rated torque value. As a result of the excessive torque, the fuse pin **122** connecting the intermediate gear **110** and the intermediate pinion **112** experiences a shearing load. The shearing load results in shearing of the fuse pin **122**, thereby causing the intermediate gear **110** to dis-engage from the intermediate pinion **112** and rotate freely on the intermediate shaft **108**. Thus, the fuse pin **122** shears when the transmitted torque through the steering system **100** exceeds the rated torque value. Hence, the intermediate gear **110** is unfastened and rotates freely on the intermediate shaft **108**. Therefore, the rotary motion of the driving shaft **104** is not transmitted to the driven shaft **114**. In other words, the fuse pin **122** acts a fuse for the steering mechanism **100** and disengages the intermediate gear **110** from the intermediate pinion **112**, thereby preventing overloading and consequent damage to the steering system **100**.

INDUSTRIAL APPLICABILITY

The present disclosure applies generally to marine vessels and specifically applicable to a steering system **100** of a marine pod drive. The steering system **100** may include a steering gear case, an input shaft, and an output shaft. The input shaft may be similar to the driving shaft **104**. The output shaft may be similar to the driven shaft **114** and may be further connected to steering linkage of the marine pod drive. The input shaft may be driven by a pod drive unit similar to the drive motor **102**. In other words, the input shaft may be a driving shaft **104** that may be rotated by the pod drive unit, such as the electronic power steering motor, a stepper motor, a hydraulic motor and the like. The input shaft and the output shaft are connected by a steering gear case. The steering gear case may include a set of gears mounted to a common shaft similar to the intermediate gear **110**, the intermediate pinion **112**, and the intermediate shaft **108**. In an embodiment, the input shaft, the steering gear case and the output shaft may be similar to the steering system **100**, as illustrated in FIG. **1**. Hence, torque may be transmitted through the input shaft to the output shaft through the steering gear case.

The output shaft may be further connected to a steering link of a propulsion unit. In general, the propulsion unit may be rotatably mounted with a hull of the marine vessel. The propulsion unit may include at least one propeller that may be rotated to produce forward or backward thrust. Further, the propulsion unit may be steered about a suitable axis, to steer the vessel. The propulsion unit can be steered by the steering link.

Hence, the output shaft steers the propulsion unit through the steering link. In other words, the rotary motion of the input shaft may be transmitted to the output shaft which in turn may be attached to steering link of the propulsion unit of the marine vessel. Hence, the rotation of the input shaft (analogous to the driving shaft **104**) causes the rotation of the output shaft (analogous to the driven shaft **114**), through the steering gear case, thereby rotating the propulsion unit.

Maneuvering the propulsion unit of the vessel requires torque to be transmitted from the input shaft to the output shaft. During such maneuvering, the transmitting torque may exceed the rated torque value. For example, while steering the vessel, wooded logs may get stuck around the propulsion unit. Operator of the vessel may try to steer the propulsion unit and in the event apply additional power through the pod drive unit. In such as scenario, the steering gear case may be subjected to torque which may exceed the rated torque value. Hence, the driving pinion and the driven gear may break or damage. Also, the pod drive unit may get over loaded and fail. However, the disclosed steering system **100** provides the fuse pin **122**. Instead, failure of gears or the pod drive unit, the fuse pin **122** shears and disengages the input shaft from the output shaft. Thus, the excess load can be prevented from being transmitted through the steering system **100**. Hence, the fuse pin **122** protects the steering system **100** of a marine pod drive from damage. Also, in an event of excessive load, the sheared fuse pin **122** may be replaced easily without having to disassemble the propulsion unit or the input or output shaft of a marine pod.

It should be understood that the above description is intended for illustrative purposes only and is not intended to limit the scope of the present disclosure in any way. Thus, those skilled in the art will appreciate that other aspects of the disclosure can be obtained from a study of the drawings, the disclosure, and the appended claim.

What is claimed is:

1. A steering system for a marine pod drive, comprising:
- a driving shaft;
- a driving pinion attached to the driving shaft;
- a driven shaft;
- a driven gear mounted to the driven shaft;
- an intermediate shaft;
- an intermediate gear mounted to the intermediate shaft and in mesh with the driving pinion;
- an intermediate pinion, attached to the intermediate shaft and in mesh with the driven gear; and
- a fuse pin configured to fasten the intermediate gear with the intermediate pinion, wherein the fuse pin is configured to shear when a transmitting torque exceeds a rated torque value.

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